A comparative study of variations in arithmetic fluency between Norwegian and Finnish third graders

Funderud, Tonje

2019-10-20

þÿFunderud , T , Mononen , R , Radiai , J & Laine , A 2019 , ' A compar
variations in arithmetic fluency between Norwegian and Finnish third graders ' , European
Journal of Special Needs Education , vol. 34 , no. 5 , pp. 572-585 . https://doi.org/10.1080/08856257.2018.1560618

http://hdl.handle.net/10138/316918
https://doi.org/10.1080/08856257.2018.1560618

unspecified
acceptedVersion

A Comparative Study of Variations in Arithmetic Fluency between Norwegian and Finnish Third Graders

Tonje Funderud[1)], Riikka Mononen[1)], Jelena Raid"[2)] and Anu Laine[3)]

[1)] Department of Special Needs Education, University of Oslo, Norway

[2)] Department of Teacher Education and School Research, University of Oslo, Norway

[3)] Faculty of Educational Sciences, University of Helsinki, Finland

Correspondence concerning this article should be addressed to Riikka Mononen, Department of Special Needs Education, P.O. Box 1140, Blindern, 0318 Oslo, Norway. Email: r.m.mononen@isp.uio.no. Tel: +47-22855638

A Comparative Study of Variations in Arithmetic Fluency between Norwegian and Finnish Third Graders

Abstract

The study aimed to investigate variations in addition and subtraction fluency by observing grade three students in Norway (n = 253, M_{age} = 8.38 y.) and Finland (n = 209, M_{age} = 9.35 y) while controlling for their age and non-verbal reasoning. Gender differences were also examined. The focus of the study was on the performance of the low-achieving (LA) students in comparison to the typically achieving (TA) group, not neglecting differences in how early educational support was organised across the two countries. Two-minute speed tests in both addition and subtraction within the 20 number range were used to assess fluency. The Finnish students outperformed students in the Norwegian sample both in addition and subtraction fluency. There were more Norwegian students in the LA group (i.e. performance at or below the 25th percentile) in both addition (37.9% vs. 20.1%) and subtraction (39.1% vs. 15.8%). In comparison to the TA students, the LA students made more errors and skipped over more arithmetic tasks in an attempt to solve them. Observed differences are discussed in relation to both country characteristics concerning early mathematics education and early educational support.

Keywords: arithmetic fluency, arithmetic skills, comparative study, low achievers, third grade students

Introduction

Numeracy skills, both independently and as part of general mathematical competence, are considered crucial to future employment in the modern labour market. At the same time, low academic achievement and learning difficulties (e.g., mathematical learning difficulties) are among the key predictors of school dropout (Hakkarainen, Holopainen, and Savolainen 2015; Korhonen, LinnanmŠki, and Aunio 2014; Rumberger and Lim 2008). Estimates suggest that 5Ð7% of students have severe difficulties (i.e. developmental dyscalculia) in learning mathematics (2011), and if the low-achieving (LA) students are included, the number rises to 15Ð20% (Geary 2011). Students having learning difficulties in mathematics are often characterized as having severe problems in basic arithmetic (Mazzocco, Devlin and McKenney 2008; Vanbinst, Ghesqui•re, and De Smedt 2014). While their peers are mostly fluent (i.e., accurate and fast) in solving basic arithmetic problems, these students rely on more immature and slower strategies, such as using their fingers as memory aids, and verbal counting. The difficulties in arithmetic fluency are usually identified around grade three (i.e., approximately at the age of nine), as this is the time when students following typical development start to be fluent in addition and subtraction especially within the number range from 0 to 20 (Aunio & RŠsŠnen 2016). Grade three students experiencing arithmetic fluency difficulties, in both Norway and Finland, are in the focus of this study.

In Norway, students begin with formal instruction in arithmetic at the age of six. In contrast, most six-year-olds in Finland are taking part in pre-primary education and start formal schooling at the age of seven. During this preparatory year, the children are introduced to different topics in mathematics mainly through playful activities, but no formal teaching in arithmetic is provided (Finnish National Board of Education [FNBE] 2016a). By the time they reach grade three, students in both countries will receive formal mathematics instruction for three school years. Notably, the Finnish pupils will be a year older than their Norwegian peers.

Another difference between the countries relates to the educational support system. In Finland, a three-tier model is followed, emphasising early support (Finnish National Agency for Education [FNAE] 2010), whereas, in Norway, students need to go through an external professional assessment concerning possible learning difficulties before they can receive any special educational support (Oppl¾ringslova [Education law] 2005, ¤5-1).

Both these aspects represent an interesting starting point for the current investigation on arithmetic fluency in grade three students. More closely, the aim of this study is to investigate variations in addition and subtraction fluency of third graders in Norway and Finland, while controlling for their age and non-verbal reasoning. Gender differences are also observed. Subsequently, departing from the existing differences in how early educational support differs between the countries, we will also examine (a) if there are differences in the proportion of LA students between the two countries, and (b) if there are differences in the patterns how the LA students solve the arithmetic tasks compared to their typically achieving (TA) peers.

Individual Differences in Arithmetic Development

In so far, some typical trajectories in the development of arithmetic skills have been identified. At the same time, individual differences have also been found following this development (Dowker 2009; Vanbinst, Ceulemans, Ghesqui•re, and De Smedt 2015). As research shows, arithmetic problems are typically solved using one of two basic approaches: retrieval strategies or backup strategies (Ostad 2013; Siegler and Jenkins 1989). Retrieval strategies are based on retrieving units from long-term memory, either as a whole unit (6 + 6 = 12) or as associations with a unit (**6 + 6** = 12, so 6 + 7 = one more, thus 13). Backup strategies, on the other hand, are based on using verbal counting to solve the problem, such as counting both addends (i.e. primary strategies) or counting up or down from any addend (i.e. more complex strategies) (Ostad 2013; Siegler and Jenkins 1989). Following the typical development trajectory, children start out using the primary backup strategies and gradually move on to more complex backup strategies, which include fewer counting steps, and move towards retrieval strategies. Simultaneously, they practice variation and flexibility in the use of strategies and start to adapt them to the task at hand (Dowker 2014; Ostad 1997, 1999; Siegler and Jenkins 1989). Canobi (2004) found that children in grades 1–3 were more fluent in solving addition than subtraction problems. Furthermore, counting on was the most used strategy in addition problems, whereas counting-up in subtraction. Thus, in this study we also treat addition and subtraction as separate components of arithmetic. As children get older, they use more advanced ways to solve arithmetic problems (Canobi, 2004). Around the age of nine, children typically begin to use fact retrieval as their primary strategy for addition and subtraction, and calculations within the number range 0–20 become fluent (Aunio and RŠsŠnen 2015).

Although

with a limited degree of change or development of strategies through primary school (Dowker 2009; Ostad 1997, 1999). In their study, Jordan, Hanich and Kaplan (2003a) compared children with good and poor arithmetic fact mastery across second and third grade. They found that general cognitive skills were a significant predictor of the use of finger counting to solve arithmetic tasks. Additionally, they showed that children with poor arithmetical fact mastery performed significantly lower on a measure of verbal abilities than the children with good arithmetic mastery. Furthermore, Vanbinst and colleagues (2015) found three different profiles of arithmetic development when observing grades three to five: 1) slow and variable, 2) average and 3) efficient, with a conclusion that symbolic numerical magnitude processing is an important factor in contributing to individual differences in arithmetic skills. They found no differences between the groups in digit naming, working memory or non-verbal reasoning. To conclude, the developmental trajectory of children with DD in arithmetic fact retrieval will most likely never catch up with that of TA children, but difficulties are rather persistent (Jordan et al. 2003a). However, LA children, although starting behind TA children, seem to exhibit better growth than children with DD, and their trajectory is rather similar to that of TA children, only delayed (Geary, Hoard, Nugent, and Bailey 2012; Ostad 1997, 1999).

Gender Differences in Arithmetic

Although there are studies